

## CLAIMS

1. A method for forging a hollow rack bar from a metal blank pipe, comprising the steps of:

5       (a) subjecting the blank pipe to a plastic deformation process for an adjustment of a cross-sectional shape of the metal blank pipe;

10      (b) holding said adjusted metal blank pipe by a die having toothed portions so that the toothed portions are contacted with the blank pipe at its outer surface, and;

15      (c) inserting, under a pressure, a mandrel into the blank pipe held by the die for causing the metal to be flown toward toothed portions, thereby forming on the outer surface of the blank pipe toothed portions having shapes corresponding to those of the toothed portions of the die.

2. A method according to claim 1, wherein said adjusting step adjusts the cross-sectional shape of the blank pipe to a predetermined shape.

20      3. A method according to claim 1, wherein the step (a) for subjecting the blank pipe to a plastic deformation process for an adjustment of a desired cross-sectional shape of the metal blank pipe comprises the steps of:

subjecting the blank pipe to swaging process for reducing the diameter of the blank pipe, and;

25      subjecting the said swaged pipe to an ironing process for producing a desired cross-sectional shape of the blank pipe.

30      4. A method for forging a hollow rack bar from a metal blank pipe, comprising a pre-forming step and a main forming step after the execution of the performing step, the pre-forming comprises the steps of:

(a) subjecting the blank pipe to swaging process for reducing the diameter of the blank pipe;

35      (b) clamping the swaged blank pip by a clamping die of a desired shape at the outer periphery thereof, while locating a working core inside the blank pipe, and;

(c) withdrawing the working core so that the blank pipe

is swaged at its inner diameter side, thereby generating a desired shape of the hollow cavity of the blank pipe extending in an axial and radial directions;

said main forming comprises the steps of:

5 (d) holding the pre-formed blank pipe from its outer side by a rack forming die having toothed portions; and

10 (e) inserting, under a pressure, a mandrel to the inner diameter cavity of the blank pipe, thereby forming on the outer surface of the blank pipe toothed portions having shapes corresponding to those of the rack forming die.

15 5. In a method for forging a hollow rack bar from a metal blank pipe, wherein the blank pipe is, from its outer side, held by a rack forming die, and a mandrel is inserted to the blank pipe under a pressure, thereby forming a hollow rack bar having shape corresponding to toothed portion of the rack forming die, the improvement wherein prior to the forging of the hollow rack bare, the blank pipe is subjected to a plastic deformation process for obtaining an adjustment of the cross-sectional shape of the blank pipe.

20 6. A method for forging a hollow rack bar from a blank metal pipe, comprising the steps of:

(a) holding said blank pipe by means of a cramping die having, at its inner periphery, toothed portion for forming the rack, and;

25 (b) inserting, at a pressure, a mandrel into the blank pipe, while, during the insertion, the mandrel causes the metal to be subjected to simultaneous expanding functions at different locations of the toothed portions along the longitudinal direction, thereby forging the blank pipe to a hollow rack bar.

30 7. An apparatus for forging a hollow rack bar from a blank metal pipe, comprising:

35 a die for holding the blank pipe from its outer surface, said die having at its inner surface toothed portions for forming a rack, and;

a mandrel for inserting, at a pressure, into the blank

pipe held by the die, said mandrel having enlarged head for causing, during the insertion, the metal to be expanded outwardly toward the toothed portions, so that toothed portions corresponding to those at the die are formed on the outer surface  
5 of the blank pipe,

10 said mandrel comprising forging means for causing, during the insertion of the mandrel, the blank pipe to be subjected, at different location along the length, to simultaneous expansive forged actions at different locations of the toothed portions along the length of the mandrel.

15 8. An apparatus according to claim 7, wherein said forging means comprises a plurality of operating heads in the mandrel, of gradually increased operating diameters in the direction of the insertion of the mandrel.

10 9. An apparatus according to claim 7, wherein said forging means comprises an operating head and a plurality of grooves on the operating head spaced along the length of the mandrel, said grooves being inclined opposite to the direction of the inclination of the toothed portions of the die.

20 10. An apparatus for forging a hollow rack bar from a blank metal pipe, comprising:

a die for holding the blank pipe;  
a holder for a piece on which toothed portions are formed,  
and;

25 a mandrel for inserting, at a pressure, into the blank pipe held by the die, said mandrel being for forging the metal blank so that toothed portions corresponding to the shapes of the toothed portions of the die are formed on the blank pipe, thereby forming a rack bar;

30 said holder having an opening therethrough, to which said toothed portion forming piece is embedded.

11. An apparatus according to claim 10, wherein said opening for embedding the toothed portion piece has, at its ends space along the length, recessed portions of an increased  
35 radius.

12. An apparatus according to claim 11, further

comprising a fluid cylinder built in the holder, said fluid cylinder being for mounting the holder to the die.